Scientific Inquiry

7-1 The student will demonstrate an understanding of technological design and scientific inquiry, including the process skills, mathematical thinking, controlled investigative design and analysis, and problem solving.

7-1.4 Explain the importance that repeated trials and a well-chosen sample size have with regard to the validity of a controlled scientific investigation.
Taxonomy Level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 1st grade (1-1.3), students carried out simple scientific investigations when given clear directions. In 2nd grade (2-1.1), students carried out simple scientific investigations to answer questions about familiar objects and events. In 3rd grade (3-1.7), students explained why similar investigations might produce different results. In 4th grade (4-1.3), students summarized the characteristics of a simple scientific investigation that represent a fair test (including a question that identifies the problem, a prediction that indicates a possible outcome, a process that tests one manipulated variable at a time, and results that are communicated and explained). In 8th grade, students will recognize the importance of a systematic process for safely and accurately conducting investigations (8-1.2) and will explain the importance of and requirements for replication of scientific investigations (8-1.5).

It is essential for students to know that for an investigation to be scientifically valid, replication within the procedures is important to verify the results and produce valid conclusions. Scientists want to report true results; therefore, they conduct repeated trials so that patterns or trends in the data can be determined. The more data that is collected through replication, the more reliable the results. Without replication, errors in procedures or data collection may not be detected.

While gathering data during an experiment:
- Data needs to be gathered more than one time under the same conditions and with the same measurement tools.
- Repetition ensures that the experiment is *valid* and that the data is reliable.
  - Validity indicates how close the investigation is to being accurate and dependable.
  - As a result of validity, other investigations repeated the same way should produce similar results.
- When possible, measurements should be taken several times, and then the results averaged.
- Each set of repeated data is called a *trial*.

An investigation may involve a *sample*, or a portion of the total number, as a type of estimation.
- The sample is used to take a representative portion of the objects or population for research.
- A poorly chosen sample size can be unrepresentative of the whole.
- Careful observations made from a proper sample size or manipulating variables within that sample size result in information and conclusions that might apply to the whole population.

If an investigation is designed with too few trials or with an improper (too small) sample size, experimental data and the results will have invalid foundations. Reasons why a repeated investigation could produce different results may be:
- The setup of the materials was not followed properly.
- Similar procedures were not followed in the exact same way.
- Appropriate tools were not chosen to complete the investigation.
- Tools were not used properly.
- Measurements were not taken accurately.
- Different observations were collected.
- Mistakes were made when recording data such as numbers written incorrectly.

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Assessment Guidelines:

The objective of this indicator is to *explain* the importance that repeated trials and well-chosen sample sizes have with regard to the validity of a controlled scientific investigation; therefore, the primary focus of assessment should be to construct a cause-and-effect model showing the importance of repeated trials and well-chosen sample sizes to ensure validity. However, appropriate assessments should also require students to *summarize* reasons why the results of an investigation may produce different results; *recall* the importance of a well-chosen sample size; *identify* conditions necessary to collect valid data; or *exemplify* valid investigations.